## Executive Summary

### ES-1.0 Introduction

### ES-1.1 Scope of this TMDL

The scope of this TMDL is water temperature in the main stem segments of the Columbia River from the Canadian Border (River Mile 745) to the Pacific Ocean and the Snake River from its confluence with the Salmon River (River Mile 188) to its confluence with the Columbia River (see Figure 1-1). This TMDL addresses dams, point sources and non-point sources of thermal loading to the main stems themselves. There are 15 dams and 106 point sources on the two main stems addressed by this TMDL. The non-point sources enter the main stems primarily through tributaries and irrigation return flows. There are 193 tributaries including seven significant irrigation flows addressed in this TMDL.

### ES-1.2 Legal Authority

Under authority of the Clean Water Act, 33 U.S.C. § 1251 et seq., as amended by the Water Quality Act of 1987, P.L. 100-4, the U.S. Environmental Protection Agency is establishing a Total Maximum Daily Load (TMDL) for temperature in the main stems of the Columbia River from the Canadian Border to the Pacific Ocean and the Snake River from its confluence with the Salmon River to its confluence with the Columbia River. EPA is establishing the TMDL for waters within the states of Washington and Oregon and waters within the reservations of the Confederated Tribes of the Colville Reservation and the Spokane Tribe of Indians. The Idaho Department of Environmental Quality is simultaneously issuing the TMDL for waters within the jurisdiction of the State of Idaho. The States of Oregon and Washington requested that EPA establish the TMDL for waters within those two States.

EPA has authority under section 303(d) of the Clean Water Act (CWA) to approve or disapprove TMDLs submitted by the states and tribes and to establish its own TMDLs in the event that it disapproves a state or tribal submission. EPA views section 303(d) as vesting it with a general authority to ensure meaningful and timely implementation of section 303(d). This is the basis for EPA's establishment of TMDLs when requested by the States or for tribes that have not been authorized to establish TMDLs under section 518(e) of the CWA.

### ES-2.0 Applicable Water Quality Standards

Three states and one Indian Tribe have WQS standards promulgated pursuant to section 303(c) of the CWA that apply to the Columbia and Snake Rivers: Idaho, Oregon, Washington and the Confederated Tribes of the Colville Reservation. Another Indian tribe, the Spokane Tribe of Indians has WQS for the Columbia River that have been adopted by the tribe but not yet approved by EPA. The WQS for each state and tribe for the portions of the Columbia and Snake Rivers subject to this TMDL are summarized below.

Table ES-2.1 summarizes the WQS that apply to the Columbia and Snake Rivers. Where jurisdictions overlap for a particular river reach, the table includes the more stringent standard that applies to that reach. Along the ID/OR border, the Oregon standard is more stringent. Along the ID/WA border, the Washington standard is more stringent. In the lower reach along the Oregon/Washington Border, Washington's standard is more stringent when natural temperatures are lower than the criterion of 20 °C but Oregon's standard is more stringent when natural temperatures are above the criterion. In the Reach between Grand Coulee Dam and Chief Joseph Dam, the Colville standard is more stringent.

**Table 2-3: Summary of Water Quality Standards that Apply to the Columbia and Snake Rivers**

| Columbia River Reach | Criterion | Natural Temp < Criterion | Natural Temp > Criterion |
|---|---|---|---|
| Canadian Border to Grand Coulee Dam | 16 °C | Natural + 23/(T+5) | Natural + 0.3 °C |
| Grand Coulee Dam to Chief Joseph Dam | 16 °C | Natural + 23/(T+5) | Natural + 0.3 °C |
| Chief Joseph Dam to Priest Rapids Dam | 18 °C | Natural + 28/(T+7) | Natural + 0.3 °C |
| Priest Rapids Dam to Oregon Border | 20 °C | Natural + 34/(T+9) | Natural + 0.3 °C |
| Oregon Border to mouth | 20 °C | Natural + 1.1 °C | Natural + 0.14°C |
| Snake River Reach | Criterion | Natural Temp < Criterion | Natural Temp > Criterion |
| Salmon River to OR/WA Border | 12.8/17.8 °C | Up to Criterion | Natural + 0.14 °C |
| OR/WA Border to ID/WA Border | 20 °C | Natural + 1.1 °C | Natural + 0.3 °C |
| ID/WA Border to Mouth | 20 °C | Natural + 34/(T+9) | Natural + 0.3 °C |

t = the maximum permissible temperature increase measured at a mixing zone boundary
T = the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge.

## ES-3.0 Technical Considerations

### ES-3.1 Mathematical Modeling

The WQS that apply to the Columbia River require derivation of the specific target temperatures for the TMDL based on natural temperatures in the river (see Table 2-3). Natural temperature is considered to be the water temperature that would exist in the river in the absence of any human-caused pollution or alterations. There is little temperature data available for the free flowing Columbia and Snake rivers that would reflect natural temperature prior to the advent of these human sources of thermal energy in the watershed such as development, agriculture, forestry, and dams. Therefore, it is necessary to simulate natural temperatures in order to derive the specific temperature targets for the TMDL.

RBM 10, a one dimensional, energy budget mathematical model was developed to simulate temperature in the Columbia River. It simulates daily cross sectional average temperatures under conditions of gradually varied flow. Actual river flow data and regional meteorological data was used to simulate water temperature in the existing developed river and in the free flowing river with dams and point sources mathematically removed.

**ES-3.2 Site Potential Temperature**

This simulation strategy provides the temperatures that would occur in the Columbia and Snake rivers within the TMDL study area in the absence of human activity within the main stem of the river within the study area. These temperatures are referred to in the TMDL as site potential temperatures. As the name implies, they are the temperatures that could occur in the Columbia and Snake rivers within the TMDL study area if the influence of human activity in the main stems on water temperature is eliminated. These are not natural temperatures because the inputs to the model (weather, tributary flow and temperature and boundary condition flow and temperature) are the existing conditions and they are not natural. However, as the water quality standards require, site potential temperature represents the water temperature in the absence of human activity in the TMDL study area.

There is one exception to the use of existing conditions to the boundaries of the TMDL. Dworshack Dam on the North Fork of the Clearwater River has been operated since 1991 to discharge colder water from its reservoir as a means of improving flow and temperature conditions downstream in the Snake River to aid in the recovery of endangered salmon. Since these Dworshack releases of cold water are part of implementation efforts for restoring temperatures in the Snake River they should not be included in the simulations of site potential temperature. Therefore, Clearwater Rivers flows and temperatures have been adjusted to eliminate the discharges from the dam from 1991 through 1999 that were intended for salmon and water quality recovery.

Figure ES3-1 illustrates the site potential temperature and the actual temperature during 1977 at John Day Dam as simulated by the RBM10 model. The figure illustrates the typical differences between the site potential or free flowing river and the existing impounded river. The free flowing river tends to warm faster in the spring, but cool faster in the fall and winter. Temperature in the free flowing river also tends to vary more in response to changes in air temperature.

The site potential temperature is not constant throughout the year, from year to year or along the length of the river. There are warm years and cool years and the water tends to warm as it moves downstream. The estimates of site potential and ultimately the TMDL target temperatures have to account for that variation. The longitudinal variability is captured by dividing the river into a series of reaches and estimating the site potential at a target site in each reach. In this case, 15 reaches were designated, 1 for each dam in the river. The Target Site for each reach is in the tailrace of the dam at the foot of each reach. The yearly variability in site potential temperature was captured by simulating 30 years of site potential temperatures and computing the mean site potential temperature. Figure 3-2 illustrates the variability of site potential temperatures and the mean site potential at John Day Dam as simulated by RBM 10.

### ES-3.3 Implications of Using Daily Cross Sectional Average Temperature Simulations

The site potential temperatures which form the basis for the target temperatures in this TMDL are based on simulations of daily cross sectional average temperature. The water quality standards of the 3 states and tribe for temperature include criteria written in terms of maximum temperature or seven day average of daily maximum temperatures. However, the standards themselves allow temperature to exceed natural (site potential) temperature only by small incremental amounts (see Table ES2-3).

The un-impounded or free flowing river was well mixed. Temperature was fairly constant from top to bottom and from side to side. Thus, the cross sectional average temperature of the free flowing river is a good representation of the temperature in the free flowing river.

Water temperature can vary throughout the day with changing air temperature and solar radiation. Simulations of hourly average temperature using the RBM 10 model demonstrate that the diel variation in the free flowing or site potential river is greater than in the impounded river. In fact, there is little heating and cooling cycle, as measured by cross sectional average temperature, during the day in the impounded river. While the two rivers may have the same maximum temperature, the site potential river will cool off during the night while the impounded river will stay warmer. In this scenario, the impounded river would not exceed WQS (site potential temperature plus a small increment) during the hot part of the day because it is the same temperature as the site potential but it would exceed WQS at night because it is warmer than site potential. On this same day, although the maximum temperatures of the two rivers were the same, the daily average temperature of the impounded river was warmer. If the river temperature was regulated to daily maximum temperature under this scenario it would be under-protected. It would carry a heat load during the day higher than the site potential river. The daily average temperature is a more appropriate measure to ensure that human activity does not cause the temperature to exceed site potential temperature. It is important to note that the site potential and impounded river water temperatures do not often coincide on the same day. It is far more usual for the temperature of the two rivers to be completely distinct on a given day, especially the 30 year mean temperatures that form the basis for target temperature. The situation in which the daily maximum temperatures are equal but the daily averages are different rarely occurs. Usually the impounded river temperature is clearly higher or lower than the site potential temperature. In this case, regulating to the daily average temperature is conservative because the impounded temperature won’t raise during the day to the site potential maximum.

## ES-4.0 Current Temperature Conditions

### ES-4.1 General

Temperature conditions in the Columbia and Snake river main stems are discussed in detail in Appendix A, “Problem Assessment for the Columbia/Snake River Temperature TMDL”

(Problem Assessment). The analysis in the Problem Assessment provides the following information about the natural and existing temperature regimes of the river:

- The temperatures of the Columbia and Snake rivers frequently exceed state and tribal numeric water quality criteria for temperature during the summer months throughout the area covered by this TMDL.

- The water temperatures of the rivers before construction of the dams could get quite warm, at times exceeding the 20 $^{o}$C temperature criteria of Oregon and Washington on the lower Columbia River.

- However, these warm temperatures were much less frequent without the dams in place. Temperature observations show that the frequency of exceedances at Bonneville Dam of 20 $^{o}$C increased from about 3% when Bonneville was the only dam on the lower river to 13% with all the dams in place.

- Global warming or climate change plays a role in warming the temperature regime of the Columbia River. The Fraser River, with no dams, shows an increasing trend in average summer time temperature of 0.012 $^{o}$C/year since 1941, 0.022 $^{o}$C/year since 1953.

- The average water temperatures of the free flowing river exhibited greater diurnal fluctuations than the impounded river.

- The free flowing river average water temperature fluctuated in response to meteorology more than the impounded river. Cooling weather patterns tended to cool the free flowing river but have little effect on the average temperature of the impounded river.

- The free flowing river water temperatures cooled more quickly in the late summer and fall.

- Alluvial flood plains scattered along the rivers moderated water temperatures, at least locally, and provided cool water refugia along the length of the rivers.

- The existing river can experience temperature gradients in the reservoirs in which the shallow waters are warmer.

- Fish ladders, which provide the only route of passage for adult salmon around the dams, can become warmer than the surrounding river water.

### ES-4.2 Relative Impact of Dams, Tributaries and Point Sources on Temperature in the Columbia and Snake Rivers.

The Columbia and Snake Rivers are both quite large. The 7Q10 low flow of the

Columbia ranges from 45,400 CFS at Grand Coulee Dam to 93,652 below Longview, WA. The 7Q10 low flow of the lower Snake is 14,500 CFS. Both rivers can accept a large advected thermal load from point sources and tributaries without measurably increasing their temperature. RBM 10 simulations demonstrate that the increase in temperature due to the point sources never approaches the 1.1 °C allowed by water quality standards when site potential is below the criterion, nor the 0.14 °C increase allowed by the water quality standards. Likewise, most of the tributaries have negligible effects on the cross sectional average temperature of the main stems. For example, the Deschutes River must be 16 °C warmer than the Columbia when both are at average flows, for the Deschutes to raise Columbia water temperature by 0.5 °C.

Dams, on the other hand, can have much more significant effects on temperature, with Grand Coulee causing temperatures as high as five degrees over site potential. It is also important to point out that only 7 of the fifteen dams have note worthy impacts: Grand Coulee, Chief Joseph, John Day, Lower Granite, Little Goose, Lower Monumental and Ice Harbor. Also the effects of the dams are more pronounced in the late summer and fall.

**ES-5.0 Derivation of Target Temperatures for the TMDL**

The temperature targets for this TMDL are the mean site potential temperatures plus the incremental increases allowed by the WQS. These allowable increases vary with jurisdiction, location in the river and the site potential temperature. Where jurisdictions overlap, the allowable incremental increases in this TMDL are based on the more stringent WQS. Table ES2-3 lists the allowable increases over the site potential by river reach after accounting for differences between jurisdictions.

The target temperatures result from adding the allowable increases to the site potential temperature. However, whenever the allowable increase in a river reach would result in exceedance of the water quality standards downstream of that reach, the target temperature has to be adjusted down so that it does not result in exceedance of down stream water quality standards. This actually is the case along most of the river. Most reaches cannot have the full incremental increase allowed by standards because they would cause exceedance of downstream standards. The water quality standards of the lowest reach on the river, along the Oregon/Washington border (see table ES2-3) limit the allowable increase in temperature in the rest of the Columbia and Snake Rivers. The allowable temperature increases of the upstream reaches shown in Table ES2-3 must all be adjusted down in order the meet the water quality standards of that down stream reach. Therefore, the allowable temperature increases actually must be allocated among the reaches.

There are many ways to allocate the temperature increases among the reaches. Three have been considered for this draft TMDL to solicit public comment.

- Allocate the same increase to every reach. Set that increase so that water quality standards are achieved in the lowest reach.
- Allocate increases to the reaches in proportion to the impact that the reach has on temperature. A reach’s increase would depend on the difference between the

actual temperature in the reach and site potential temperature.

- Allocate sufficient increase to each reach to allow for the discharge of existing point sources plus some future growth; allocate the remaining capacity to the dams.

This TMDL is based on the third approach, allocating sufficient increase to each reach to allow for the discharge of existing point sources and some future growth. The point sources have a very small effect on water temperatures in the Columbia and Snake Rivers, in and of themselves, never leading to exceedances of water quality standards as measured by the daily cross sectional average temperature. For that reason it makes sense to develop target temperatures that allow for the existing discharges from the existing point sources, and if possible, some future growth.

## 6.0 DERIVATION OF TMDL ELEMENTS

### ED-6.1 Target Sites

Sixteen target sites are established for this TMDL. The required elements of a TMDL under Section 303(d) of the Clean Water Act are established at these 16 Sites. The sixteen sites are the fifteen dam locations and the Cape Disappointment, Washington Coast Guard Station, the last point source discharge on the river.

### ES-6.2 Seasonal Variation

Temperature varies seasonally along the rivers as illustrated in Figure 3.1. Note that temperature in the impounded river system exceeds the water quality criterion of 20 °C in the summer at John Day Dam. This is typical of both rivers. Generally, along their lengths they exceed water quality criteria during the summer. Along the entire river system, the time period during which criteria are exceeded tends to be from June 1 through September 15.

### ES-6.3 Critical Conditions

It is difficult to establish critical conditions of stream flow, loading and water quality parameters (temperature in this case) for this TMDL because of the manner in which dams effect temperature and the manner in which the target temperature varies throughout the year. Dams do not discharge a heated effluent to the river. They effect temperature by altering stream geometry and current velocity. Therefore, dams don’t necessarily have the greatest effect on temperature at the lowest flows as they would if they discharged a heated effluent at constant discharge rate to the river. Furthermore, since the target temperature varies throughout the year, the hottest time of the year is not necessarily the most likely time that water quality standards will be exceeded.

This TMDL is based on simulations of site potential temperature using 30 years of actual hydrologic and climatologic data. By using this entire extensive record the TMDL accounts for most of the natural variability in the system and will be protective of water quality under all conditions that occurred during those 30 years. However, the wasteload allocations for point sources are based on the 7Q10 low flow in the rivers.

### ES-6.4 Loading Capacity and Load Available for Allocation

The loading capacity at each target site is the daily target temperature at that site. The daily target temperature is the mean site potential temperature plus the incremental increase allowed by the water quality standards. The loading capacity at each target site is expressed graphically and in tabular form in Appendix 1 (Appendix 1 is not done yet). Figure ES6-1 depicts the loading capacity for John Day Dam.

### ES-6.5 Load and Wasteload Allocations

At each target site the loading capacity is allocated to site potential temperature, existing human activities and some future development. The temperature available for allocation to human activities and future development at each target site is the incremental increase above site potential allowed by the water quality standards. Table ES6-1 breaks down the temperatures available for allocation into gross Wasteload Allocations (WLA) and Load Allocations (LA). That is, WLA and LA for all the human activities in each reach. The WLAs are for existing point sources. The LAs are for dams.

**Table ES6-1: Gross WLA and LA at Each Target Site** (Need John's results to fill this in)

| Target Site | Load Available for Allocation | | Gross Wasteload Allocation | | Gross Load Allocation | |
|---|---|---|---|---|---|---|
| | Site Potential < criteria | Site Potential > criteria | Site Potential < criteria | Site Potential > criteria | Site Potential < criteria | Site Potential > criteria |
| Grand Coulee | 0.14 °C | 0.02 °C | .005 °C | .005 °C | .135 °C | .015 °C |
| Chief Joseph | | | | | | |
| Wells | | | | | | |
| Rock Reach | | | | | | |
| Rock Island | | | | | | |
| Wanapum | | | | | | |
| Priest Rapids | | | | | | |
| McNary | | | | | | |
| John Day | | | | | | |
| The Dalles | | | | | | |
| Bonneville | | | | | | |
| Lower Granite | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Little Goose | | | | | | |
| Lower Monumental | | | | | | |
| Ice Harbor | | | | | | |
| | | | | | | |

Table 6-2 expresses the WLA and LA as incremental increases in temperature over site potential temperature. However, site potential temperature is a simulated temperature, not a temperature that can be measured in the river. Furthermore, the site potential temperature varies every day throughout the year. Therefore, Appendix 1 lists the Site Potential Temperature, the Loading Capacity and the gross WLA and LA for each Target Site, every day of the year. The loading capacity is the target temperature for the target site after the effects of human activity are added to site potential temperature. Loading capacity and site potential temperature are expressed as 30 year means.

The gross WLA and LA expressed in Table 6-2 are broken into individual allocations for the 106 point sources, 15 dams and non-point sources in the following sections.

### ES-6.5.1 Wasteload Allocations

The gross WLAs in Table ES6-1 are allowable temperature increases at each target site attributable to point sources. These temperature increases are the maximum increases caused by the point sources for 30 years of model simulations. The individual WLAs discussed below are presented in terms of heat load. They cumulatively represent the heat load discharged by point sources that will result in the allowable temperature increases expressed in Table 6-2.

#### Bubble Allocations and Individual Allocations

Very small heat load dischargers that increase Columbia or Snake River daily cross sectional average temperature by 0.014 °C or less are grouped into “bubble allocations”. Dischargers that increase the daily cross sectional average temperature by more than 0.014 °C are provided individual allocations. One hundred ninety four dischargers are included in bubble allocations and 12 have individual allocations.

#### Maximum Discharge Levels

The target temperatures for this TMDL were established to allow existing point sources to discharge at their current thermal loads. However, the WLA loads in this TMDL are the maximum discharge levels that the point sources could receive when their NPDES permits are issued. The permit limits may be lower than the loads established here for two reasons: adherence to State/Tribal mixing zone requirements and application of State/Federal/Tribal minimum technology requirements. When NPDES permits are renewed, the permitting authority will evaluate each facility’s compliance with mixing zone requirements and minimum technology requirements. The effluent limits in the permit may be lower than those established in this TMDL as a result of those analyses.

There are 106 point sources covered by this TMDL. The WLA for these point sources are computed as megawatts. Tables ES6-2 and ES6-3 characterize the allocations of each river reach in the Columbia River and Snake River respectively showing the number of facilities in the bubble allocations, the size of the bubble allocations and the number and size of individual allocations in each reach.

Table ES6-2: Characterization of Wasteload Allocations in each Reach of the Columbia River

| Columbia | Bubble Allocations | | Individual Allocations | | Totals | |
|---|---|---|---|---|---|---|
| River Reach | Number | Load (MW) | Number | Load (MW) | Number | Load (MW) |
| International Border - Grand Coulee | 1 | 1.3742442 | 0 | 0 | 1 | 1.3742442 |
| Grand Coulee - Chief Joseph | 3 | 4.5228915 | 0 | 0 | 3 | 4.5228915 |
| Chief Joseph - Wells | 4 | 3.7864583 | 0 | 0 | 4 | 3.7864583 |
| Wells - Rocky Reach | 4 | 8.021054 | 0 | 0 | 4 | 8.021054 |
| Rocky Reach - Rock Island | 8 | 70.805746 | 0 | 0 | 8 | 70.805746 |
| Rock Island - Wanapum | 3 | 0.4529858 | 0 | 0 | 3 | 0.4529858 |
| Wanapum - Priest Rapids | 0 | 0 | 0 | 0 | 0 | 0 |
| Priest Rapids - McNary | 8 | 224.13589 | 3 | 1125.4194 | 11 | 1349.5553 |
| McNary to John Day | 1 | 39.812813 | 0 | 0 | 1 | 39.812813 |
| John Day - The Dalles | 2 | 0.7245424 | 0 | 0 | 2 | 0.7245424 |
| The Dalles - Bonneville | 9 | 24.360412 | 1 | 160.32272 | 10 | 184.68313 |
| Bonneville - Coast | 44 | 1321.3071 | 7 | 2650.333 | 51 | 3971.6401 |
| Total | 87 | 1699.3042 | 11 | 3936.0751 | 98 | 5635.3793 |

Table ES6-3: Characterization of Wasteload Allocations in each Reach of the Snake River

| Snake | Bubble Allocations | | Individual Allocations | | Totals | |
|---|---|---|---|---|---|---|
| River Reach | Number | Load (MW) | Number | Load (MW) | Number | Load (MW) |
| Salmon R - Lower Granite | 2 | 10.280357 | 1 | 298.78587 | 3 | 309.06622 |
| Lower Granite to Little Goose | 1 | 0.0193944 | 0 | 0 | 1 | 0.0193944 |
| Little Goose - Lower Monumental | 2 | 1.3924709 | 0 | 0 | 2 | 1.3924709 |
| Lower Monumental - Ice Harbor | 1 | 0.0039229 | 0 | 0 | 1 | 0.0039229 |
| Ice Harbor - Columbia R. | 1 | 0.0039467 | 0 | 0 | 1 | 0.0039467 |
| Totals | 7 | 11.700091 | 1 | 298.78587 | 8 | 310.48596 |

### ES-6.5.2 Load Allocations

#### ES-6.5.2.1 Nonpoint Sources

The nonpoint sources of thermal energy to the Columbia and Snake River mainstems discharge to the rivers via tributaries. There are 193 tributaries including seven significant irrigation return flows in the TMDL project area. Thirty of them are on the 303 (d) lists for temperature. There is no flow or temperature information available for many of the tributaries, and as already described in section 4, very few of the tributaries are large enough to effect water temperature in the mainstem. For these reasons, only the largest 25 tributaries are part of the RBM 10 model.

For this TMDL, the WQS for the mainstem and most of the tributaries are based on the site potential temperatures. The site potential temperatures in the main stems have been estimated using existing tributary loads. The tributary loads that would occur if the tributaries were at site potential temperatures is not available. The tributary loads of the 30 tributaries on the 303(d) lists may be less at site potential temperature than they currently are and the site potential temperature in the mainstems may therefore be somewhat less when the tributaries are at site potential temperatures than the current estimates. **But while the overall loading capacity or target temperature of the mainstems may decrease a small amount, the capacity available for allocation to human activities in the mainstem will not change. That is, the gross WLA and LA will not change.** Therefore, in this TMDL, the tributaries are allocated their existing loads unless a TMDL has been established for a tributary. In that case, the tributary's load allocation for this TMDL is set at the established load allocation. To date, temperature TMDLs have been established for one tributary to the Columbia and Snake river mainstems: the Umatilla River.

The gross WLA s and LAs given in Table ES6-1 are for excess temperature added to the mainstems by point sources, nonpoint sources and dams. Site potential temperature estimates for the main stems are based on existing tributary loads. So there is no excess temperature in the site potential estimates due to tributaries. Therefore, none of the load allocations in Table ES6-1 apply to the tributaries or to non-point sources. The entire load allocation is available for the dams. When the tributaries are at site potential temperatures they do not cause any excess temperature in the mainstems. However, WQS for the tributaries allow small increases over site potential. When the TMDLs are completed for those tributaries, the target temperatures in the TMDLs may have to restrict those allowable increases to achieve the downstream standards in the mainstems just as upstream allowable increases are restricted in this TMDL.

#### ES-6.5.2.2 Dams

Dam structures are legally considered to be point sources that do not discharge pollutants. As such, they do note receive NPDES permits. Therefore, wWe are including the temperature allocations for dams as LAs and reserving WLAs only for those point sources that require an NPDES permit.

The LAs for the dams are those listed in Table ES6-1 under Gross LA. These load allocations will be difficult to monitor in the field or to develop temperature improvement measures around. To make the TMDL more useful in planning temperature improvement measures at the dams and to make it more easily monitored, the LA is a;sol expressed in terms of:

- resulting water temperature;
- temperature improvement needed at each dam; and
- temperature difference between respective Target Sites.

These three analyses, taken together will allow for advanced planning to mitigate the temperature impacts of dams and for short and long term monitoring of the effectiveness of improvement measures in achieving the TMDL.

Water temperature resulting from achievement of the TMDL WLA and LA is actually the loading capacity expressed as the thirty year mean temperature. This provide information on the long term improvement in temperature that will be achieved by implementation of the TMDL and will be useful in monitoring the ultimate long term effectiveness of TMDL implementation.

The effect that each dam has on water temperature by itself, or the temperature improvement needed at each dam was decsribed by using RBM 10 to simulate river conditions under the scenarios that each of the current 15 dams is the only dam in the river. The effects of the dams vary greatly, ranging from maximum effects in the range of 0.x °C for xxxxx Dam to over 5.0 °C for Grand Coulee. After Grand Coulee Dam, John Day Dam and the four Snake River dams appear to have the most meaningful effect on water temperature.

RBM 10 was used to determine the difference in temperature between all the successive dams when they are all achieving their TMDL LAs. This temperature difference can be very valuable in monitoring the effectiveness of implementation measures in the short term at specific dams. The maximum temperature differences are around 0.2 to 0.3 °C when dams are meeting their TMDL targets and they generally occur in early summer. In the existing river, the maximum temperature differences are as great as 1.5 °C and tend to occur much later in the year, around day 300 (end of October). The short term effectiveness of implementation measures at a particular dam can be evaluated by comparing the temperature difference between it and the upstream target site to the RBM 10 simulations.

### 6.6 Margin of Safety

There has been implicit margin of safety built into the TMDL.

- For point sources the TMDL allows no measurable increase over the numerical criterion at the 7Q10 low flow. This is conservative in two ways. First, point sources do not use additional loading that would result from utilizing the site potential temperature instead of the numerical criterion. Second, the flows in the late summer and fall are generally higher than the 7Q10 low flow.

- For dams, the use of daily average temperatures is

- For dams and point sources, the Oregon WQS that apply to the lower reach of the Columbia River which coincides with the Oregon/Washington border is the basis for the TMDL target temperatures. When the site potential temperature exceeds the numeric criteria, no measurable increase (0.14 °C or more) is allowed over site potential. This is conservative during the summer months because Colville and Washington WQS allow a 0.3 °C increase.

## 7.0 Summary of the TMDL, WLAs and LAs

Table ES 7.1 summarizes the TMDL, the WLAs and the LAs for each river reach. The load avaliable for allocation, as well as the gross WLA and the gross LA are prsented in bold for each river reach. The bubble WLA, the individual WLAs and the individual LA follow the gross allocations for each reach. The bubble and individual WLAs are given as megawatts. The LAs are given as the temperature increase in °C that the facility is allowed.

**Table 7-1: Summary of the Columbia/Snake River TMDL, showing gross allocations for each river reach and individual wastload or load allocation for each facility in every reach.**

| **River Reach** / Facility | **Load Available for Allocation** | | **Wasteload Allocation** | **Load Allocation** | |
|---|---|---|---|---|---|
| | Site Potential < criteria | Site Potential > criteria | One allocation applies at all times throughout the year | Site Potential < criteria | Site Potential > criteria |
| **International Border to Grand Coulee** | **0.14 °C** | **0.02 °C** | **0.005 °C** | **.135 °C** | **.015 °C** |
| Bubble | | | 1.37 MW | | |
| Grand Coulee Dam | | | | .135 °C | .015 °C |
| **Grand Coulee to Chief Joseph** | **0.14 °C** | **0.02 °C** | **0.005 °C** | **.135 °C** | **.015 °C** |
| Bubble | | | 5.52 MW | | |
| Chief Joseph Dam | | | | .135 °C | .015 °C |
| **Chief Joseph to Wells** | **0.14 °C** | **0.02 °C** | **0.005 °C** | **.135 °C** | **.015 °C** |
| Bubble | | | 3.79 MW | | |
| Wells Dam | | | | .135 °C | .015 °C |
| **Wells to Rocky Reach** | **0.14 °C** | **0.02 °C** | **0.005 °C** | **.135 °C** | **.015 °C** |
| Bubble | | | 8.02 MW | | |
| Rocky Reach Dam | | | | .135 °C | .015 °C |
| **Rocky Reach to Rock Island** | **0.14 °C** | **0.02 °C** | **0.005 °C** | **.135 °C** | **.015 °C** |
| Bubble | | | 70.81 MW | | |
| Rock Island Dam | | | | .135 °C | .015 °C |
| **Rock Island to Wanapum** | **0.14 °C** | **0.02 °C** | **0.005 °C** | **.135 °C** | **.015 °C** |

| | | | | | |
|---|---|---|---|---|---|
| Bubble | | | 0.45 MW | | |
| Wanapum Dam | | | | .135 °C | .015 °C |
| **Wanapum to Priest Rapids** | **0.14 °C** | **0.02 °C** | **0.005 °C** | **.135 °C** | **.015 °C** |
| Priest Rapids Dam | | | | .135 °C | .015 °C |
| **Priest Rapids to McNary** | **0.14 °C** | **0.02 °C** | **0.005 °C** | **.135 °C** | **.015 °C** |
| Bubble | | | 224.14 MW | | |
| Agrium Bowles Road | | | 405.82 MW | | |
| Agrium Game Farm Road | | | 484.69 MW | | |
| Boise Cascade Walulla | | | 234.90 MW | | |
| McNary Dam | | | | .135 °C | .015 °C |
| **McNary to John Day** | **0.14 °C** | **0.02 °C** | **0.005 °C** | **.135 °C** | **.015 °C** |
| Bubble | | | 39.81 MW | | |
| John Day Dam | | | | .135 °C | .015 °C |
| **John Day to The Dalles** | **0.14 °C** | **0.02 °C** | **0.005 °C** | **.135 °C** | **.015 °C** |
| Bubble | | | 0.72 MW | | |
| The Dalles Dam | | | | .135 °C | .015 °C |
| **The Dalles to Bonneville** | **0.14 °C** | **0.02 °C** | **0.005 °C** | **.135 °C** | **.015 °C** |
| Bubble | | | 24.36 MW | | |
| SDS Lumber | | | 160.32 | | |
| | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Bonneville Dam | | | | .135 °C | .015 °C |
| **Bonneville to the Coast** | **0.14 °C** | **0.02 °C** | **0.005 °C** | **.135 °C** | **.015 °C** |
| Bubble | | | 1321.31 MW | | |
| Georgia Pacific | | | 313.21 MW | | |
| Boise/ St.Helens | | | 219.56 MW | | |
| Coastal St. Helens | | | 365.09 MW | | |
| PGE Trojan | | | 511.15 MW | | |
| Longview Fiber | | | 540.99 MW | | |
| Weyerhouser Longview | | | 398.63 MW | | |
| GP Wauna | | | 301.71 MW | | |
| **Salmon River to Lower Granite** | **0.14 °C** | **0.02 °C** | **0.005 °C** | **.135 °C** | **.015 °C** |
| Bubble | | | 10.28 MW | | |
| Potlatch | | | 298.76 MW | | |
| Lower Granite Dam | | | | .135 °C | .015 °C |
| **Lower Granite to Little Goose** | **0.14 °C** | **0.02 °C** | **0.005 °C** | **.135 °C** | **.015 °C** |
| Little Goose Dam | | | | .135 °C | .015 °C |
| **Little Goose to Lower Monumental** | **0.14 °C** | **0.02 °C** | **0.005 °C** | **.135 °C** | **.015 °C** |
| Bubble | | | 1.38 MW | | |
| Lower Monumental Dam | | | | .135 °C | .015 °C |
| **Lower Monumental to Ice Harbor** | | | | | |

| | **0.14 °C** | **0.02 °C** | **0.005 °C** | **.135 °C** | **.015 °C** |
|---|---|---|---|---|---|
| Ice Harbor Dam | | | | .135 °C | .015 °C |